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**Klärwerk Flensburg**

- Size: 224,000 P.E.
- Approx. 10 million m3 wastewater / year
- Process combination:
- Preliminary sedimentation, activated sludge process, advanced treatment (trickling filter, sludge bed reactor, 2-stage filtration) filtration), turbid water treatment.

The TBZ Flensburg wastewater treatment plant has a goal to improve their carbon footprint and to achieve climate neutrality. Through the application of sewage gas, the plant already covers own heating plus 1,000 MWh to Flensburg's district heating system as well as a large part of its own electricity requirements.

Additionally, the WWTP produces 35,000 kW/h through photovoltaics and 15,000 kW/h via hydropower. The plant also plans to convert the entire vehicle fleet to e-cars and expand the photovoltaics to supply itself up to 100% in the foreseeable future.

measure to k$N_2O$w

# Identifying $N_2O$ at the Flensburg wastewater treatment plant

"The biggest change was the knowledge we gained about our nitrous oxide sources at the Flensburg wastewater treatment plant."

In 2022, the TBZ Flensburg wastewater treatment plant started a series of small measurement campaigns to identify the primary sources of nitrous oxide in their processes. The project is part of the plant's goal to achieve climate neutrality. Jan Philipp Schnack, Civil Engineer and Innovation Project Manager, was responsible for the project in co-operation with Robin Schauser, student at the Flensburg University of Applied Sciences.

The Flensburg plant contains several steps that deviate from the typical setup. So, the team identified 7 measuring points in the plant sections where nitrogen degradation takes place.

| Reactor | Main Selection Criterion |
|---|---|
| 1: Upstream denitrification | Denitrification |
| 2: Aeration tank | Nitrification |
| 3: Trickling filter | Nitrification |
| 4: Sludge bed reactor | Denitrification |
| 5: Fixed bed reactor mainstream | Nitrification |
| 6: Fixed bed reactor sidestream | Nitrification, high $NH_4$ concentration |
| 7: Fine filtration denitrification | Denitrification |

The main $N_2O$ formation pathways are during nitrification and denitrification as a by-product of the biological conversion of nitrogen.

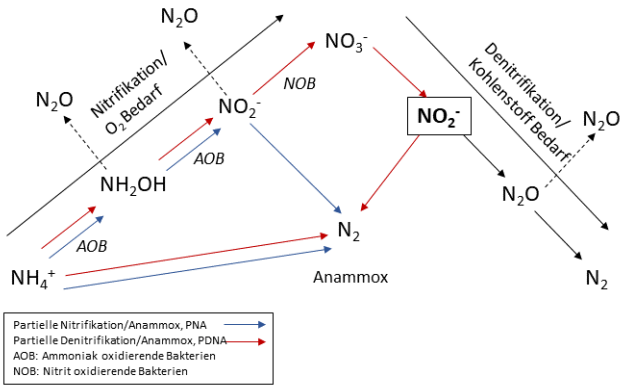


Fig. 1: $N_2O$-Formation in wastewater treatment plants

"The investment costs had initially deterred us somewhat. However, the knowledge and results we gained made up for it. We see the benefits of using the system in the long term."

**Flexible measurements showed $N_2O$ variations**

The measuring campaigns of 1-2 weeks at each spot took place from October to February. "The flexible use of the datalogger between the different measuring points was an advantage. We could easily pull the stored data onto a USB stick, for viewing and evaluation", says Jan Philipp.

The results from the measurement campaigns showed low nitrous oxide formation in the main stream and low to typical nitrous oxide formation in side stream treatment. "Our results show that we are dealing with low nitrous oxide levels. But we could identify two places where nitrous oxide is formed", explains Jan Philipp. However, $N_2O$ production often shows strong seasonal variations, so it is necessary to monitor it over a year to get a comprehensive picture.

**Plans for efficient management**

In the future, nitrous oxide measurements will provide data for Flensburg wastewater treatment plant's $CO_2$-equivalent accounting on their road to climate neutrality.

Jan Philipp has further plans for the system: "One of our next steps for the $N_2O$ Wastewater System is to integrate it into our process control system. We are also considering a possible use for the control of our C-source dosing. Furthermore, we want to gain knowledge about possible fluctuations in nitrous oxide formation through long-term use at a measuring point. Our goal will then be to take countermeasures to achieve an improvement of the wastewater treatment plant."

**Author**

Dr. Bastian Piltz, Sales Engineer

Learn more about the work at the Flensburg wastewater treatment plant in this webinar (in German):
$N_2O$ ist das größte Klimaproblem auf der Kläranlage.
Available at unisense-environment.com/webinar-n2o-ist-das-grosste-klimaproblem-auf-der-klaranlage/

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# Nitrous Oxide process sensor for online wastewater treatment optimization, low-cost greenhouse gas reduction, and reliable sustainability accounting


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